

## CLAIMS

What is claimed is:

1. A method comprising:  
operating a logging tool in a borehole, the logging tool having a transmitting antenna;  
transmitting from the transmitting antenna an electromagnetic wave having a first frequency;  
transmitting from the transmitting antenna an electromagnetic wave having a second frequency; and  
transmitting from the transmitting antenna an electromagnetic wave having a third frequency.
2. The method as defined in claim 1 further comprising selectively tuning the transmitting antenna for each of the first, second and third frequencies.
3. The method as defined in claim 2 wherein the selectively tuning step further comprises controlling an amount of capacitance coupled to the transmitting antenna.
4. The method as defined in claim 3 wherein controlling an amount of capacitance further comprises operating a relay to selectively control an amount of capacitance coupled to the transmitting antenna.
5. The method as defined in claim 4 wherein the operating the relay step further comprises sending a control signal for the relay across a signal line that couples to the transmitting antenna and that carries an antenna signal.

6. The method as defined in claim 2 wherein the selectively tuning step further comprises controlling inductance of the winding antenna.
7. The method as defined in claim 6 wherein the controller step further comprises operating a relay to selectively couple windings of the transmitting antenna.
8. The method as defined in claim 7 wherein the operating the relay step further comprises sending a control signal for the relay across a signal line that couples to the transmitting antenna and that carries an antenna signal.
9. The method as defined in claim 1 wherein the operating step further comprises operating a logging while drilling tool in the borehole.
10. A logging tool comprising:
  - a tool body adapted for use in a borehole;
  - a receiving antenna disposed on the tool body; and
  - a transmitting antenna disposed on the tool body at a spaced apart location from the receiving antenna;wherein the transmitting antenna is selectively operable at three or more resonant frequencies for transmitting electromagnetic radiation.
11. The logging tool as defined in claim 10 further comprising an antenna tuning circuit coupled to the transmitting antenna, the antenna tuning circuit operable to selectively couple capacitance to the transmitting antenna to obtain the three or more resonant frequencies.

12. The logging tool as defined in claim 11 wherein the antenna tuning circuit further comprises:

a relay having a coil, the coil coupled to a signal line that carries signals to the transmitting antenna;

said relay having a set of contacts selectively coupled by activation of the coil; and

wherein in a first contact position a capacitance is coupled to the transmitting antenna, and

wherein in second contact position the capacitance is not coupled to the transmitting antenna.

13. The logging tool as defined in claim 12 wherein the relay couples within a junction box proximate to the transmitting antenna.

14. The logging tool as defined in claim 10 further comprising an antenna tuning circuit coupled to the transmitting antenna, the antenna tuning circuit operable to selectively couple windings of the transmitting antenna to obtain the three or more resonant frequencies.

15. The logging tool as defined in claim 14 wherein the antenna tuning circuit further comprises:

a relay having a coil, the coil coupled to a signal line that carries signals to the transmitting antenna;

said relay having a set of contacts selectively coupled by activation of the coil; and

wherein in a first contact position a first set of windings of the transmitting antenna is coupled in parallel with a second set of windings of the transmitting antenna, and wherein in second contact position the first set of windings of the transmitting antenna is coupled in series with the second set of windings of the transmitting antenna.

16. The logging tool as defined in claim 15 wherein the relay couples within a junction box proximate to the transmitting antenna.

17. The logging tool as defined in claim 10 further comprising:  
a plurality of receiving antennas disposed in the tool body;  
a plurality of transmitting antennas disposed on the tool body; and  
wherein at least one of the plurality of transmitting antennas is selectively operable at three or more resonant frequencies.

18. The logging tool as defined in claim 17 further comprising:  
three receiving antennas disposed on a medial portion of the tool body;  
three transmitting antennas disposed on a first end of the tool body; and  
three transmitting antennas disposed on a second end of the tool body.

19. The logging tool as defined in claim 18 wherein the tool body further comprises a tool body adapted for use within a drillstring.

20. A bottom hole assembly comprising:  
a drill bit;  
a logging tool coupled to the drill bit, the logging tool comprising:  
a tool body;  
a plurality of receiving antennas disposed on the tool body; and  
a plurality of transmitting antennas disposed on the tool body at a spaced apart location from each other and the receiving antennas;  
wherein each transmitting antenna is selectively operable at greater than two resonant frequencies for transmitting electromagnetic radiation.

21. The logging tool as defined in claim 20 further comprising a plurality of antenna tuning circuits coupled one each to the plurality of transmitting antennas, each antenna tuning circuit each selectively couples capacitance to its respective transmitting antenna to achieve the greater than two resonant frequencies.

22. The logging tool as defined in claim 21 wherein each antenna tuning circuit further comprises:

a relay having a coil, the coil coupled to a signal line that carries signals to a transmitting antenna;

said relay having a set of contacts selectively coupled by activation of the coil; and

wherein in a first contact position a capacitance is coupled to the transmitting antenna, and

wherein in second contact position the capacitance is not coupled to the transmitting antenna.

23. The logging tool as defined in claim 22 wherein the relay couples within a junction box proximate to its respective transmitting antenna.

24. The logging tool as defined in claim 20 further comprising a plurality of antenna tuning circuits coupled one each to the transmitting antennas, each antenna tuning circuit operable to selectively couple windings of a transmitting antenna to achieve the greater than two resonant frequencies.

25. The logging tool as defined in claim 24 wherein each antenna tuning circuit further comprises:

a relay having a coil, the coil coupled to a signal line that carries signals to a transmitting antenna;

said relay having a set of contacts selectively coupled by activation of the coil; and

wherein in a first contact position a first set of windings of the transmitting antenna is coupled in parallel with a second set of windings of the transmitting antenna, and wherein in second contact position the first set of windings of the transmitting antenna is coupled in series with the second set of windings of the transmitting antenna.

26. The logging tool as defined in claim 25 wherein the relay couples within a junction box proximate to its respective transmitting antenna.

27. A logging tool comprising:

a receiving antenna on a tool body;

a transmitting antenna on the tool body at a spaced apart location from the receiving antenna;

a junction box proximate to the transmitting antenna, the junction box comprising:

a relay having a coil coupled to a signal line that carries an antenna signal;

a set of contacts whose contact position is controlled by the coil;

a capacitor coupled to the set of contact and the transmitting antenna; and

wherein the coil is activated by a control signal carried on the signal line, and

wherein the contacts selectively couple the capacitor to the transmitting antenna.

28. The logging tool as defined in claim 27 wherein the junction box further comprises:

a second relay having a coil coupled to the signal line;

a second set of contacts whose contact position is controlled by the coil of the second relay;  
and  
wherein the transmitting antenna comprises a first and second antenna winding, and where  
the contacts selective couple the first and second antenna winding in one of a parallel  
coupling and a series coupling.

29. A method comprising:

operating a logging tool in a borehole, the logging tool having a first and second antennas;  
transmitting an electromagnetic wave having a first frequency from the first antenna; and  
tuning the second antenna to resonate at a second frequency during transmitting by the first  
antenna, the second frequency different than the first frequency.

30. The method as defined in claim 29 wherein the tuning the second antenna step further  
comprises controlling an amount of capacitance coupled to the second antenna.

31. The method as defined in claim 29 wherein the tuning the second antenna step further  
comprises controlling inductance of the second transmitting antenna.

32. A logging tool comprising:

a means for housing electronics and transmitters, the means for housing for use in a borehole;  
a means for receiving electromagnetic signals disposed on the means for housing; and  
a means for transmitting electromagnetic signals disposed on the means for housing.